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A study of the relationship between the understanding of the basic genetic concepts and perspectives regarding genetically modified products and local production among undergraduate and High School students

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Abstract

Biotechnological education is an unavoidable challenge that the educational system needs to examine in order to guarantee that citizens can understand the constant developments of biotechnological knowledge.In this vein, this research consists of a preliminary attempt to try to pave the way to a better comprehension of the conceptual and cognitive foundations of the critical understanding of genetic engineering. To this end, the research studies three variables among a wide range of undergraduate and high school students: the knowledge about basic genetic concepts, the tendency to support or criticize the production of food and the attitudes towards local production.

Keywords: Biotechnological education, psychological factors, Higher education

1. Introduction

Nowadays the competence to assess the social, ecological and economic implications of scientific and technological development is a necessary social skill implicitly aimed at modern citizens. However several influential studies have underlined a significant lack of knowledge regarding biotechnological issues among non-specialist people and the general public in contemporary society (Cámara & Monsalve, 2002; Shane, Morris & Adleyb, 2001).

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In this vein, it has been reported that only one in four adult European citizens seems to be accurately informed with respect to biotechnological matters and that only a third of the adult population demonstrates an intermediate level of understanding of these issues (Pardo, Midden & Miller, 2002).

However, it turns out to be without doubt that the present outstanding development of genetic engineering directly influences each and every citizen in current societies whether by means of the emergence of new foods and medicines based on genetic engineering production systems or by means of emerging ethical and economic dilemmas in areas such as agriculture or human reproduction.

In this context, it has been pointed out the biotechnological education is an unavoidable challenge that the educational system needs to confront in order to guarantee that, on the one hand, citizens can understand the constant developments of biotechnological knowledge and, on the other hand, that they can effectively take part in the ongoing social debate regarding the technical applications arising from genetic engineering (Vanderschuren, Heinzmann, Faso, Stupak, Yalc, Hoerzer, Laizet, Leduchowska, Silva & Simkova, 2010). Likewise, one of the main objectives of scientific and technological literacy is to develop an appropriate sense of responsibility towards making citizens capable of taking part in the social decision making processes (Vilches & Gil, 2008).

2. Objective

This research consists of a preliminary attempt to try to pave the way to a better comprehension of the conceptual and cognitive foundations on which a critical understanding of technical applications for genetic engineering (specifically, genetically modified foods) and, also, the individual preferences toward local and regional food production are based.

To this end, a wide range of teacher training students are examined and compared with other undergraduate students in terms of (a) knowledge about basic genetic concepts, (b) tendency to support or criticize the production of food by genetic engineering techniques and (c) attitudes towards regional and local production.

The final objective of this investigation is aimed at contributing to the understanding of how well-reasoned critical thinking about controversial issues linked to scientific development emerges and what can be done in the educational arena to promote analytical thought related to technological progress, especially among those who will be in charge of educational responsibilities.

3. Methods

3.1. Characteristics of the sample

This research has been conducted by analysing data coming from 365 college and High School students (67.4% female and 32.3% male). Table 1 breaks down the basic characteristics of the population studied in terms of their educational background.

Table 1: Educational background distribution of the sample

	N	%
High School	15	4.1
Bachelor of Teacher Training (1st)	226	61.9
Bachelor of Teacher Training (2sd)	40	11.0
Bachelor of Teacher Training (3rd)	70	19.2
Bachelor of Biology (4th)	14	3.8
Total	365	

3.2. Scales and questionnaires

The understanding of the basic genetic concepts has been evaluated by means of a reduced version of the *Genetics Concept Assessment-GCA* (Smith, Wood & Knight, 2008). This is a survey developed to assess specifically

the knowledge of genetics by non graduate students. To carry out this research 10 out of the 25 items that the survey offers were used. The chosen items were selected by general consent among the researchers of this investigation and also bearing in mind those items that could be the most suitable and appropriate to analyze the genetic knowledge of the target sample considered.

Moreover, the *Knowledge, Attitudes towards Genetic Modification* (Christoph, Bruhn & Roosen, 2008) was utilized to look into the attitudes towards genetically modified technology. This 22-Likert-items questionnaire evaluates 5 different subscales: (a) the *Support of Genetic Modification*, (b) the *Criticism of Genetic Modification*, (c) the *Trust in Monitoring and Institutions*, (d) the *Attitude towards Progress* and (e) the *Scepticism towards Innovation*.

Finally the individuals' perspectives towards regional and local production were evaluated through the *Local Food Scale* (Harmon & Maretzki, 2006) which consists of 9 items. Apart from the aforementioned questionnaires, data regarding gender, age and type of studies taken by individuals of the sample were collected.

3.2. The collection of and processing of data

Cronbach's alpha was used in order to measure the internal consistency of questionnaires and subscales. Furthermore, given that the sample did not match the requirements to use an ANOVA analysis, nonparametric Kruskal–Wallis H-test was the chosen statistic procedure for the comparison of averages. The level of significance used in the investigation was $p<0.05$ and the statistical work was done using the SPSS version 18 software.

All the data were collected during the 2010-2011 academic year by the researchers have signed this paper.

4. Results

As a starting point of the study, the reliability of the questionnaires and scales used was examined. In this respect, the Cronbach's alph of both the Predisposition to Local Food production and Knowledge of Genetic Notions scored around 0.7 which justifies the use of these surveys.

Regarding the Knowledge, Attitudes towards Genetic Modification, two of its 5 subscales reached a score over 0.7. These subscales were: the *Support of Genetic Modification* and the *Criticism of Genetic Modification*. However, the rest of the subscales did not achieve the minimal score of 0.6 score and as a result of this lack of internal consistency data drawn from the subscales the *Trust in Monitoring and Institutions*, the *Attitude towards Progress* and *the Scepticism towards Innovation* was no longer considered in the subsequent analyses.

Moreover, table 2 presents the statistic descriptors of the sample regarding the chosen scales. Gender differences are presented in the case of the predisposition to local food production since that this is the only scale that indicates actual differences between males and females (Kruskal–Wallis H-test=5.4 [1]; $p<0.02$).

Table 2: Statistic descriptors of questionnaires and subscales considered

		N	Mean	SD
The knowledge on genetic notions		364	3.8	1.9
The support of genetic modification		349	2.8	0.5
The criticism of genetic modification		349	3.5	0.6
Predisposition to local food production	Male	245	3.4	0.5
	Female	116	3.5	0.6

Finally, Table 3 breaks down the statistic descriptors from the chosen questionnaires and scales in terms of the types of the studies.

Table 3: Statistic descriptors of scales and questionnaires considering the types of studies

		N	Mean	SD
The knowledge on genetic notions	High School	15	6.3	1.1
	Bachelor of Teacher Training (1st)	226	3.7	1.7
	Bachelor of Teacher Training (2sd)	40	2.4	2.0
	Bachelor of Teacher Training (3rd)	70	3.7	1.8
	Bachelor of Biology (4th)	14	6.9	1.7
The support of genetic modification	High School	15	3.0	0.6
	Bachelor of Teacher Training (1st)	213	2.8	0.5
	Bachelor of Teacher Training (2sd)	39	2.7	0.5
	Bachelor of Teacher Training (3rd)	69	2.6	0.5
	Bachelor of Biology (4th)	13	3.0	0.7
The criticism of genetic modification	High School	15	3.3	0.6
	Bachelor of Teacher Training (1st)	213	3.5	0.6
	Bachelor of Teacher Training (2sd)	39	3.4	0.6
	Bachelor of Teacher Training (3rd)	69	3.6	0.6
	Bachelor of Biology (4th)	13	2.7	0.9
Predisposition to local food production	High School	15	2.9	0.5
	Bachelor of Teacher Training (1st)	224	3.4	0.6
	Bachelor of Teacher Training (2sd)	40	3.6	0.6
	Bachelor of Teacher Training (3rd)	69	3.6	0.5
	Bachelor of Biology (4th)	14	3.0	0.6

The differences shown are statistically significant in the case of the *Knowledge on Genetic Notions* (Kruskal–Wallis H-test=67.2 [4]; $p<0.001$); the *Support of Genetic Modification* (Kruskal–Wallis H-test=13.5 [4]; $p<0.001$); the *Criticism of Genetic Modification* (Kruskal–Wallis H-test=16.2 [1]; $p<0.001$) and the *Predisposition to local food production* (Kruskal–Wallis H-test=23.4 [4]; $p<0.001$).

5. Conclusions

Several reports and papers have warned about a significant lack of accurate knowledge on biotechnological issues among citizens in current societies and the consequences that this fact could mean in terms of failure to contribute to the current debate about the development and applications of the biotechnological knowledge (Cámara & Monsalve, 2002; Pardo et al., 2002; Shane, et al. 2001; Vanderschuren, et al., 2010).

The results presented in this paper could be useful to underline the necessity of promoting biotechnological knowledge, especially among those who are taking the educational responsibility in the near future. In this vein, the wide sample of students enrolled in teacher training studies examined in this study seems to show a significant lack of understanding of basic genetic knowledge. It is worth noting that the basic understanding of the genetic concepts analysed in this research, could be essential to grasp more complicated notions about this topic. This data appears even more apparent when the aforementioned outcomes are compared with those that Bachelor of Biology undergraduates and even High School students achieve.

Regarding the aforementioned point, it turns out to be surprising the fact that those students who achieve the lowest score in knowledge on basic genetic notions tend to exteriorize more critical perspectives regarding genetically modified production.

In this respect, the little scientific literature that has covered the topic of the influence that basic biological and genetic knowledge might have in the foundation of attitudes towards genetic engineering applications, suggests that, to some extent, the most intensive critical perspectives towards scientific controversial issues, in general, and towards genetically modified foods, in particular, are related to better scientific knowledge and understanding of scientific notions (Frewer, Scholderer, Downs & Bredahl, 2000; Haldera, Pietarinen, Havu-Nuutinen & Pelkonena, 2010; Harlen, 2006).

Even though the data presented in this study do not match the abovementioned tendency, in the light of presented results, it cannot be disputed the thought provoking positive relationship between better scientific understanding and critical thinking about controversial issues.

The opportunity remains for future studies to collect more comparative data based on samples with a wider range of educational backgrounds in order to clarify this point. However, what seems to be beyond all doubt is that a better understanding of genetic concepts that underlie biological phenomena might help teacher-to-be to strengthen their critical perspectives regarding genetically modified food.

Finally it is worth noting the usefulness of educational instruction based on socio-scientific problems (such as, for example, genetic engineering related questions) given that they encourage personal involvement with scientific issues which, eventually, would be useful to enhance pupils' scientific knowledge (Jimenez-Aleixandre, Bullago & Duschl, 2000).

References

Cámara, M. & Monsalve, I. (2002). Estudio comparativo de encuestas de opinión acerca de la biotecnología (1999-2002). *Alimentaria: Revista de tecnología e higiene de los alimentos, 338*, 11-16.

Christoph, B., Bruhn, M., & Roosen, J. (2008). Knowledge, attitudes towards and acceptability of genetic modification in Germany. *Appetite 51*, 58–68.

Frewer, L., Scholderer, J., Downs, C., & Bredahl, L. (2000). Communicating about the risks and benefits of genetically modified foods: Effects of different information strategies. Working Paper Nº 71. Retrieved on 2 of October from http://130.226.203.239/pub/mapp/wp/wp71.pdf.

Haldera, P., Pietarinen, J., Havu-Nuutinen, J.S., & Pelkonena, P.(2010). Young citizens' knowledge and perceptions of bioenergy and future policy implications. *Energy Policy, 38*(6), 3058-3066.

Harlen, W. (2006). *Teaching, learning and assessing science* 5–12 (Fourth Edition). Sage Publications Ltd. 1–264.

Harmon, A.H. & Maretzki, A.N. (2006). Assessing Food System Attitudes Among Youth: Development and Evaluation of Attitude Measures. *Journal of Nutrition Education and Behavior, 38*(2), 91-95.

Jimenez-Aleixandre, M.P., Bullago, A.B., & Duschl, R.A. (2000). ''Doing the lesson'' or ''doing science':' Argument in high school genetics. *Science Education, 84*, 757–792

Pardo R., Midden C. & Miller J.D. (2002). Attitudes toward biotechnology in the European Union. *Journal of Biotechnology 98*(1), 9–24.

Smith, M.K., Wood, W.B. & Knight, J.K. (2008). The Genetics Concept Assessment: A New Concept Inventory for Gauging Student Understanding of Genetics. *Life Sciences Education, 7*, 422–430.

Shane H. Morris, S.H., & Adleyb, C. (2001). Irish public perceptions and attitudes to modern biotechnology term an overview with a focus on GM foods. *Trends in Biotechnology, 19*(2),43-48.

Vanderschuren, H.; Heinzmann, D.; Faso, D.; Stupak, M.; Yalc, K.; Hoerzer, H.; Laizet, Y.; Leduchowska, P.; Silva, N. & Simkova, K. (2010). A cross-sectional study of biotechnology awareness and teaching in European high schools. *New Biotechnology*, *27*(6), 822-828.

Vilches, A. & Gil, D. (2008). La construcción de un futuro sostenible en un planeta en riesgo. *Alambique, 55*, 9-18